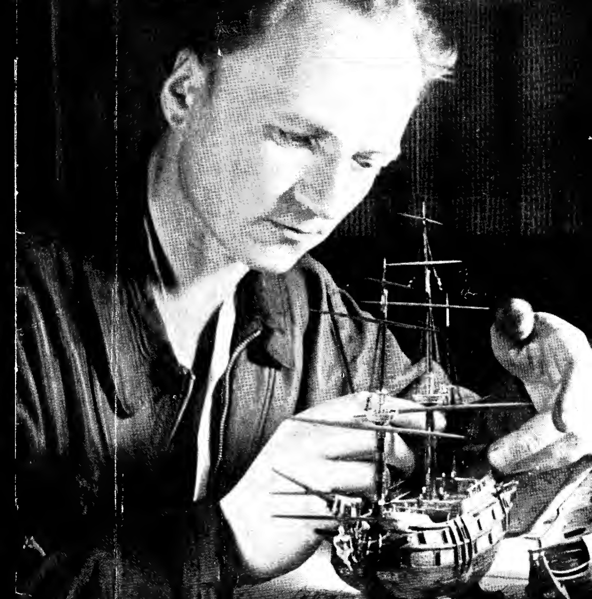
THE MODEL ENGINEER



Vol. 100 No. 2491 THURSDAY FEB 17 1949 9d.

The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

17TH FEBRUARY 1949 VOL. 100 NO. 2491

SMOKE RINGS

Our Cover Picture

● IN SPITE of the terrible conditions existing in Germany since the war, the craft of ship-modelling is by no means dead; it might even be that those who have any leanings in that direction find their hobby a real escape from the grim phase though which they are passing. Walter Grascht, of Oldenburg, finds the hobby of his youth of real help to him in these difficult days. It gives him congenial employment, and, in addition, makes him a useful member of the community, as all his models are exported to Switzerland, Sweden, America and other countries, and so help to bring much needed money into the country. He does all his own research work, obtaining his information from old books, prints and paintings. The actual making of an average model takes Grascht from two to three hundred hours.

Cover Pictures

● WE WOULD like to remind readers, once more, that we are always open to receive photographs suitable for use as cover pictures. The present style of pictorial cover is very popular, and it seems to be regarded by the great majority of readers as a kind of " signature-picture."

But suitable photographs are not always easy to find; they should be of the upright shape, and we much prefer that they shall be striking views of good, spectacular models. We have no preference for any particular type of model, so long as its portrait is of the right shape, clear and attractive. Prints submitted should be about 6 in. wide and 9 in. high, if possible, though a larger size, so long as it is of the right shape, is acceptable. Good action-pictures are especially welcome, but they must be *good*.

Photographs accepted for publication will be paid for at our standard rates. Prints should be addressed to: The Editor, THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2, and the envelope should be marked " Cover Picture."

Prize for an Electric Locomotive

● MR. F. L. GILL-KNIGHT has very generously donated £5 5s. 0d. as a prize to be awarded to the best electric locomotive entered in the forthcoming MODEL ENGINEER Exhibition.

Competitors shall have a free hand as regards design, but subject to the following considerations:

(a) The working voltage, i.e. the voltage across the supply mains shall be restricted to a maximum of 50 (fifty) volts direct current.

(b) The scale to which the locomotive is built should be confined to the usual passenger-hauling scales, i.e. $\frac{1}{2}$-in., $\frac{3}{4}$-in. and 1-in. scales.

(c) The incorporation into the model of features of full-sized electric traction practice will be considered of major importance.

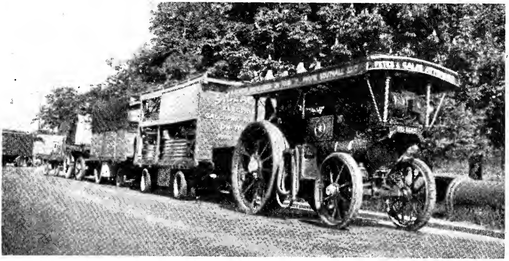
(d) Preference will be given to designs for

locomotives capable of being driven by one of the persons hauled, as distinct from models operated by the manipulation of line-side controls.

(e) "Steam outline" models are most definitely excluded, as these would defeat the whole purpose of the prize.

The design is to be sufficiently comprehensive as to permit of full working drawings to be readily prepared.

We hope that there will be a ready response to this generous offer.



A "Burrell" at Work

● THE MANY readers who are so keenly interested in road locomotives of all types will be glad to see the photograph which is reproduced on this page; it was taken by Mr. A. C. Durrant, at Richmond, on May 18th, 1948, and shows Miss S. Beach's Burrell engine, *Lord Fisher*, hauling a load of circus "gallopers." Unfortunately, this fine engine was broken up early in December. It was similar to *General French*, which was photographed at Maidenhead in September, 1946, by Mr. J. N. Maskelyne, and illustrated in THE MODEL ENGINEER for July 31st, 1947.

Unfortunate Bans

● FROM TIME to time, we hear of local authorities placing a ban upon the flying of model aircraft in parks and other open spaces; just as often, the model aircraft societies concerned put up vigorous protests against such restrictions. The usual argument is that the model aircraft enthusiast will become the designer, or pilot of the future, and therefore his hobby is, basically, of national importance, and should receive official encouragement instead of restriction. Recently, *The Evening Standard* published a rather provocative, though well-reasoned leading article on this theme.

To us, it seems that, so far, the arguments for and against the banning of model aircraft have not produced much constructive suggestion as to how the problem can be resolved, and there certainly seems to be more than a little lack of understanding on both sides, which is very unfortunate.

Municipal authorities are bound to give first consideration to the convenience and safety of residents; and if this involves the banning of a kind of model which, in certain circumstances, can become almost a lethal weapon, then the model must be banned from operating, or being operated in any conditions that might give rise to public inconvenience or danger. The obvious point is that the authorities do not ban anything unless there are very good grounds for doing so; and this means that any models which are intended to work in public parks, or other places to which the public has access, must be above suspicion.

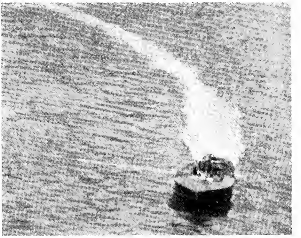
The true model engineer is essentially an adaptable and persistent individual who loves to overcome difficulties, and we do not believe that model aircraft enthusiasts are any exception to the rule. Our suggestion to them is that, instead of getting angry, they should first see that their model aircraft cannot, in any reasonable circumstances, become dangerous, and then invite municipal authorities to demonstrations for the purpose of proving the aircraft to be inoffensive. We do not think there would be any bans then.

A Prize for "Duplex" Work

● OUR CONTRIBUTORS who write under the name "Duplex" are offering a prize of £5 for the best piece of "Duplex" work to be exhibited at this year's "M.E." Exhibition. The exhibits, which, of course, must be something that has been described and illustrated in our "In the Workshop" series of articles, will be judged for accuracy of workmanship, both machine and hand work; standard of fitting and general finish, as well as the fit of any bearings in the devices. In addition, marks will be gained for new ideas, if of merit, which may be incorporated, and for any improvements made by exhibitors.

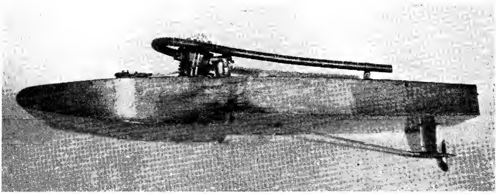
The MODEL ENGINEER 1948 Speed-Boat Competition

ONCE again we are sorry to have to report that the number of entries received for this competition is far below our expectations, and by no means representative of the considerable activity in model power boat circles, for which the 1948 season has been notable. As pointed out in a recent article, there has been a marked revival of interest and an all-round improvement in this branch of model engineering. Many veteran enthusiasts have returned to the attack with new vigour, and old boats have displayed unexpected resources of speed, while several newcomers to this field have introduced new ideas and new standards of mechanical or technical excellence. In these circumstances, it is disappointing that more of these exponents have not come forward to put the performance of their boats on record in our annual competition. The "M.E." Speed-Boat Competition is, and always has been, more than just an opportunity for the speed champion to win an extra prize to finish off the season; it furnishes a valuable survey of the year's progress in design and performance, and in this respect, it should be of great interest and practical help to all model power boat enthusiasts.

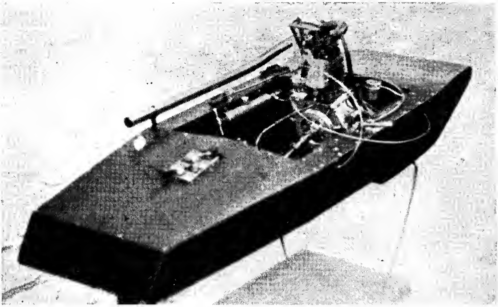


Mr. Walker's "Gilda" under way

When this competition was first organised under the title of THE MODEL ENGINEER Model Steamer Competition, its primary motive was the encouragement of research in a field of model engineering which was realised as involving some very difficult problems. In this respect, its aim has been attained, and indeed it would not be too presumptuous to say that no single factor has had so much influence on the progress of model marine engine and hull design as the incentive provided by this annual competition. It has been influential in promoting such developments as the small flash steam plant, the high efficiency petrol engine, and the design of the hydroplane. Moreover, the progress made in model speed boats and other power plants has had an important influence on model engineering generally by calling attention to the importance of good design and accuracy. In many cases, engines developed for model speed-boats have been adapted to the requirements of the more modern racing models, such as cars and aircraft. It is beyond question, therefore, that this competition has been well worth while, and that it deserves the whole-



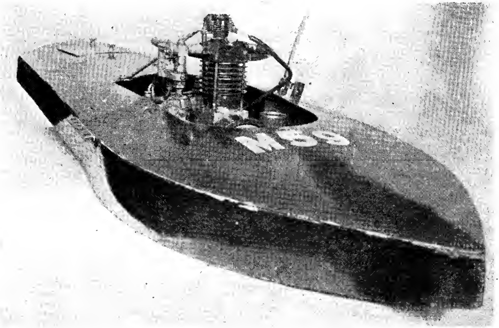
A view showing underside shape and fittings of "Faro"



"Enid," by Mr. R. Thomas

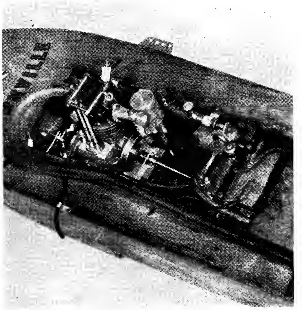
hearted support of model power boat enthusiasts.

One may perhaps be led to the conclusion that in these days when high efficiency models are commonplace, the "M.E." Speed-Boat Competition has outlived its usefulness, but even should it be conceded that it is no longer a spur to the improvement of design, by no means a conclusion to be accepted without dispute, there still remains



Simple but consistently successful: "Gilda," by Mr. E. A. Walker

its value as a record of progress and a source of valuable information on trends of design. In keeping the competition open to the end of the year and admitting the evidence provided by any properly observed run at an organised regatta or other public event, the intention has been to give the competitor the best possible chance of entering his most successful run of the season, and avoiding the inconvenience of special runs with attendance of timekeepers and witnesses.

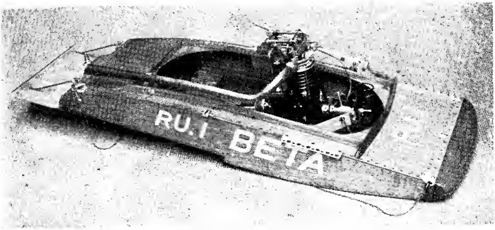


The engine of Mr. Williams' " Faro "

Some competitors may possibly be deterred from sending in their entries by the idea that the results of the competition are a foregone conclusion, but events have shown that it is often the unexpected that happens in this competition, as in many others.

We are anxious to improve the popularity of the competition and obtain entries which represent a true cross-section of the year's activities, and for this reason, we welcome any suggestion which readers may be able to put forward for making the competition more suitable for the requirements of modern times. Many such suggestions have been received in the past and have been given due consideration. Some readers have called for a removal or slackening of some of the restrictions of class rules which are thought to act as a deterrent to some prospective competitors, but restrictions of some kind or other are a necessity for classifying entries, and if discreetly applied, serve to improve the breed rather than otherwise. It has been proved in the past that a relaxing of restrictions often leads to degeneration, and concessions in this respect rarely give final satisfaction. There are no restrictions on the actual design of hull or power plant, beyond the stipulation that the hull must be water-borne and the power applied mechanically by a propeller or equivalent device. But for these restrictions, racing boats might easily have developed into " hydro-aeroplanes" or flying boats driven by rockets, such as were used by Ramus in 1873. The small flash steam plant and petrol engine, which are much more interesting from the point of view of the model engineer, might never have evolved.

Some readers have suggested that we are quite wrong in banning the commercially-produced engine or even the ready-made hull from this



Mr. Mitchell's " Beta " as run in class B

Mr. J. Cruickshank explains details of "Defiant III" to a fellow enthusiast

competition. This is a very sore point in some quarters, and is likely to be a source of further controversy, so a statement of policy in this respect is desirable. We have no prejudice whatever against the use of commercially-produced models, or any desire to influence our readers against them, but they were not the object for which the "M.E." Speed-Boat Competition was originally designed, and which is still regarded by us as the main justification for its continuance. Let it be remembered that the "M.E." exists primarily for the purpose of assisting and encouraging amateur engineering craftsmanship; that is to say, the creation, design and construction of models as distinct from their mere use or exploitation, and that being so, we should be simply betraying the best interests of our readers, to say nothing of our own, if we did not put these objects before all others.

It may be true that, as we are often told by our modern readers, competitive models have now developed into a new form of sport and are quite distinct from model construction, but we regards the sport as the culmination of workshop effort, and success in this field as the reward of ingenuity and workmanship.

Tendencies in Model Speed Boat Design

None of the boats entered in this competition shows any drastic changes in design, either of hull or power plant, though there are signs of gradual changes in development, such as the increasing use of attached planes of various types, and also the use of surface propellers. Two of the seven boats have attached planing surfaces which have been applied as additions to the original hull, and have presumably proved to confer an improvement in respect either of speed or stability. All four of the boats entered in Class A have 4-stroke engines, thus following tendencies of design which have always been popular in this class. The one representative of Class C has a 10-c.c. 2-stroke engine, again conforming to popular tendency in this class, and in Class B we see one example of flash steam plant, so that each form of propulsion plant is duly represented.

Name of Boat	Owner	Total w'ght lb.	Engine				Hull			Propeller				Speed m.p.h.
			No. of cyldrs.	Type	Bore	Stroke	Length ins.	Max. beam ins.	No. of steps	Dia. ins.	Pitch ins.	Blade area sq. ins.	No. of blades	
CLASS "A" (Boats not exceeding 16 lb.)														
Faro	K. G. Williams	15 7/16	1	4 str	ins. 1 5/16	ins. 1 5/16	40	12	1	3	6	1.84	2	51.167*
Enid	R. Thomas	15 3/4	1	4 str	1 5/16	1 5/16	35 3/4	12	1	3	6 1/2	1.55	2	47.2
Beta	R. E. Mitchell	8 1/4	1	4 str	1.07	1.00	32	15 1/2	1	3	5	1.7	2	44.5*
Gilda	E. A. Walker	11 3/4	1	4 str	1 5/16	1 5/16	40	13	1	3 1/2	7	1.05	2	36.8
CLASS "B" (Boats weighing 5 to lb.)														
Vesta II	F. Jutton	7 11/16	1	s.a. steam	7/8	7/8	30	12	1	3 1/4	8	1.8	2	41.35*
Beta	R. E. Mitchell	7 3/4	1	4 str	1.07	1.00	34	10 1/2	1	3	5	1.7	2	38.14
CLASS "C" (Boats not exceeding 5 lb.)														
Defiant III	J. Cruickshank	4	1	2 str	mm. 22.5	mm. 24	29	9	1	2 5/16	4 1/2	1.2	2	31.61

*These three runs have been accepted by the M.P.B.A. as records.

First place in Class A is taken by *Faro* by Mr. K. Williams, which is well known to readers and has featured with honour in previous "M.E." competitions. The hull and engine of this boat were built during 1935 and 1936, and the first run produced a speed of 25 m.p.h. As a result of steady development, the engine performance has been greatly improved until the speed has been more than doubled. The compression ratio has also been doubled, from 5 to 1 to 10 to 1. At the maximum speed on the water, the engine runs at an estimated speed of 11,500 r.p.m., assuming 20 per cent. propeller slip. The ignition is by coil and battery, and the timing by an oil dashpot control device as the boat accelerates. A float feed carburettor is used with air pressure bladder feed, and submerged jet with double diffuser; no throttle is fitted, but an air intake shutter is fitted to assist starting. The fuel used is a blend of 75 per cent. petrol and 25 per cent. benzol.

The second place in this class is taken by a boat which is new to the "M.E." Competition, though the boat itself is another pre-war veteran. *Enid* by Mr. R. Thomas, of the West Midlands Model Engineering Society, is very similar in design to *Faro*, and the engine has been built from castings of the same patterns as the engine of the above boat. The high performance attained by both boats is a tribute to the soundness of the engine design. Mr. Thomas, who has built several other successful models of various types including the "Midge" 0-4-0 locomotive, is a policeman by profession; evidently a real "Speed Cop"!

It will be noted that Mr. Mitchell's *Beta* is entered in both A and B classes. The reason for this is that in its initial form and before attaining its best speed, it was within the Class B weight limit, but alterations to the hull and the fitting of a silencer have increased the weight up to more than the specified 8 lb. This is a common occurrence in the development of model speed boats, but it is to be regretted that in this case it prevented the best performance of the boat from taking its due place in Class B. Mr. Mitchell is a member of the Runcorn Model Power Boat Club, a comparatively new club which has lost no time in making a name for itself.

Mr. Walker's *Gilda* is another well-known boat which has been entered in previous competitions and featured in other regatta reports as a consistent but not spectacular performer. The engine of this boat dates back to long before the war, and is of the species often referred to as a "Bitzer"; the crankcase castings and screw timing gears were obtained from Bonds, while the remaining castings and parts are those of the Grayson engine. A float-feed submerged jet carburettor, with pressure feed, and air shutter controlled by delay action gear, is employed, and ignition is by an 8 oz. coil and a 16 oz. accumulator. It may be added that the drawings of *Gilda's* hull, which we have often recommended to readers as a suitable beginner's hull, are obtainable from our publishing department; a description of the hull was given in the first issue of *Model Ships and Power Boats*.

Little need be said about Mr. Jutton's *Vesta*, which has figured very prominently and honourably in regatta reports during the last two seasons, as we have an article fully describing this boat in preparation for publication in an early issue of THE MODEL ENGINEER.

Mr. Cruickshank's *Defiant III* has a walk-over in Class C, but is fully deserving of the success which it has attained. The 2-stroke engine is of original design with opposed exhaust and transfer ports, and disc type rotary admission valve. Both Mr. Cruickshank and Mr. Mitchell employ miniature magnetos for ignition. The engine of *Defiant III* has, however, been run successfully on glow-plug ignition.

The propellers used in all boats are of the two-bladed type, varying in diameter from $2\frac{5}{16}$ in. to $3\frac{1}{2}$ in. and in pitch from $4\frac{1}{2}$ in. to 8 in. Blade areas are fairly normal in relation to other dimensions, although in the case of *Vesta II* the propeller is designed to work only partly submerged, and this no doubt accounts for the fact that its diameter and pitch are larger than usual for its class, though most flash steamers have larger propellers than petrol-driven boats.

As will be seen from the table of results, no fewer than three of the boats have broken records, in their respective classes, and in all cases the standard of performance is higher than ever. In this respect, the standard of entries make up in quality for their lack of numbers, but we venture to hope that this remaining deficiency will be remedied in the 1949 competition.

For the Bookshelf

Nineteenth Century Railway Carriages, by Hamilton Ellis. (London: Modern Transport Publishing Co. Ltd.) 176 pages, size 7 in. by 10 in. Numerous illustrations. Price 21s. net.

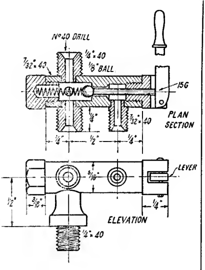
One of the peculiarities of railway history is that the locomotive has been served by a legion of able admirers who have toiled nobly to record every phase of its progress, while the railway carriage has been subject to the almost exact reverse. In this latest work by Hamilton Ellis, some attempt has been made to redeem the situation, and for the first time, we believe, a comprehensive account of the development of the railway carriage is presented between two covers.

Mr. Ellis, through his characteristic style of writing, has produced a text which, while factually correct, is often breezy and entertaining, never allowing the reader's interest to flag. The very numerous illustrations contribute a great deal to the value of the book; some of the photographs are extremely rare, and students of railway history must be for ever grateful that such pictures are now permanently available. Let us hope that the publication of this belated record may stimulate further research and recording in the same field.

Small Locomotive Boiler Fittings

by "L.B.S.C."

JUDGING from the number of times I have described how to make boiler fittings and mountings, followers of these notes should be able to make them upside down and backwards, in a manner of speaking; but there are so many newcomers to our craft—my correspondence tells a tale—that I had better briefly run through the principal operations once again. Speaking of correspondence reminds me to announce, to all whom it may concern, that what I call the "Curly Correspondence Construction College" has just got to cease operations. If there were such a thing as a Locomotive Construction Writers' Union, your humble servant would have been kicked out long since, for working about three times the "regulation" number of hours every week, with *no* time-and-a-half for Saturday afternoons, and *no* double time for Sundays and holidays. Only last week (time of writing) a new reader wanted detailed information about what tools he needed to start, also instructions on turning. I gave him a brief answer, and recommended him to the late Mr. Marshall's book. By return I got a letter asking for more information about using tools, and as he wanted to build the "Lassie" (first attempt ! !) and had only a few back issues, could I supply full instructions. That is only one example. I receive plenty of letters from enthusiastic schoolboys who imagine they can build an engine like the "Maid of Kent" in a matter of weeks, on the kitchen table, with little more than a fretwork outfit. That is no exaggeration. I spent Christmas Day doing twenty-six letters and ten airmails, which took from about 9.30 a.m. till nearly 11 p.m., and was "all in" by the time I'd finished. I just *can't* keep it up any longer.



Combined turret and whistle-valve

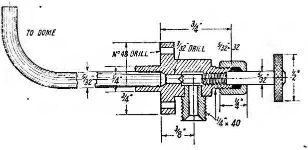
Some of our advertisers are supplying castings for my boiler fittings; so to save two lots of "how-and-why," they can be machined up in a very similar manner to the built-up pattern. The only difference is in the way they are chucked. For example, the combined whistle-valve and turret casting would have to be chucked in three-jaw by one of the larger union bosses, to turn and screw its opposite mate; then the turned one would be held in a tapped bush in the three-jaw, to turn and screw the first one. To set the small boss true for turning and screwing, the casting would have to be chucked in the four-jaw, the jaws being separately adjusted to grip the sides and ends. Same applies to the bottom fitting of the water-gauge. Personally, I prefer to use rod material for boiler fittings. If "Easyflo" in wire form (commercially obtainable) is used for silver-soldering the joints, the veriest tyro should be able to make neat fittings, with just ordinary care. In passing, I am glad to see that my pet styles of boiler fittings are now being made by our advertisers, and superseding the old museum-pieces, outsize, ugly, and inefficient, which held sway in trade catalogues for so many years.

Combined Turret and Whistle-valve

For all built-up fittings, use bronze or gunmetal rod if available; if not, use good-quality brass. For the above fitting, part off 1 in. of $\frac{5}{16}$-in. round rod; chuck in three-jaw, centre, and drill right through with No. 43 drill, open out to $\frac{3}{8}$ in. depth with $\frac{3}{16}$-in. drill, and bottom to $\frac{1}{2}$ in. depth with $\frac{3}{16}$-in. D-bit. Tap the end 7/32 in. by 40, and slightly countersink the end. Reverse in chuck, open out the other end to $\frac{3}{8}$ in. depth with $\frac{3}{16}$-in. drill, tap and countersink as above. Put a 3/32-in. parallel reamer through the remains of the "43" hole. If you haven't one, file off the end of a bit of 3/32-in. silver-steel to a long angle, like slicing a Jerry sausage; harden and temper to dark yellow, rub the flat on an oilstone, and it will ream very well.

At $\frac{1}{4}$ in. from the D-bitted end, drill a 5/32-in. hole right across; drill a similar one between them. At $\frac{1}{4}$ in. from the other end, drill a 5/32-in. hole into the enlarged passageway. The illustration shows which side to drill it. Fit union nipples, made as described for pumps and lubricator clacks, to the three side holes; and in the bottom one, a fitting made like the stem of the oil check-valve, but to the given dimensions. Silver-solder the lot at one heat; pickle, wash and clean up. Seat a $\frac{1}{8}$-in. ball on the hole in the D-bitted end; turn up a little cap from $\frac{1}{4}$-in. hexagon rod, to fit the tapped hole, and drill it No. 30 to take the spring, which is wound up from

thin bronze wire, about 30 gauge. A similar cap is needed for the opposite end; but make it from 3/8-in. hexagon rod, and drill it No. 48 right through. Screw it right home, then file away the top and bottom corners, so as to leave it rectangular. Slot it right across, 1/16 in. wide,



Injector steam-valve

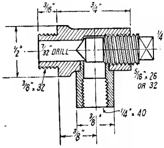
either by milling, planing, or filing. For sake of appearance, I recommend making a weeny edition of the reversing-lever, as shown, from rustless steel or nickel-bronze; but a simple bit of strip metal, pivoted on a bit of a domestic blanket-pin, or a bit of wire of similar thickness (" 56 " drill) will operate the push-rod quite well. The push-rod is a bit of 15-gauge (5/64-in.) bronze, brass or rustless steel wire, of such a length that when pressed in by the lever, it pushes the ball off the seating, and lets steam pass to the union, to which the pipe leading to the whistle is attached.

Drill and tap a 1/4-in. by 40 hole as near the edge of the wrapper-sheet as possible, over the regulator handle, and screw in the fitting with a smear of plumbers' jointing on the threads. The right-hand union is connected to the union on the blower-valve by a 1/8-in. pipe, and the left to the steam-gauge, as mentioned last week. The whistle is connected up after the boiler is erected.

Injector Steam-Valve

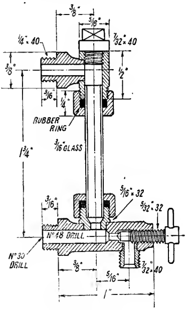
Chuck a piece of 3/4-in. rod in the three-jaw, and turn down 1/4 in. of the end to 1/4 in. diameter; face the end, centre, and drill down 1/4 in. depth with No. 24 drill. Part off at 3/4 in. from the shoulder. Reverse in chuck, gripping by the turned part. Turn down a full 5/8 in. length to 3/8 in. diameter; further reduce 1/4 in. of the end to 1/4 in. diameter, and screw 1/4 in. by 40. Centre, drill right through with 3/32-in. drill, open up with No. 30 to 1/2 in. depth, and bottom the hole with a 1/8-in. D-bit. Further open out for 1/8 in. depth with No. 21 drill, and tap the remains of the No. 30 hole with 5/32-in. by 32 tap. The slightly coarser thread gives a quicker opening.

The union-screw, valve-pin, hand-wheel and gland-nut, are all fitted as shown, and as described for the blower-valve. Drill four No. 48 holes through the flange; fit a piece of 5/32-in. copper pipe into the end, long enough to reach up into the dome. You can get the length of this from the actual job; I get all my own pipe lengths by using either a bit of thick lead fuse-wire, or a piece of soft copper wire, as a template. The pipe can be silver-soldered in at the same heat, when doing the union-screw, and softened for easy bending at the same time. The flange is then attached to the backhead, same way as the regulator flange; drill a 1/4-in. clearing hole at position shown in illustration of backhead complete, insert the pipe, wangle it



Screw type blowdown-valve

about until it appears through the dome hole behind the regulator-valve, then drill and tap the screwholes in the backhead, and fix with a 1/64-in. " Hallite " or similar gasket between flange and backhead. Note—the union-screw should hang straight down; recollect this when bending the internal pipe.



Water-gauge

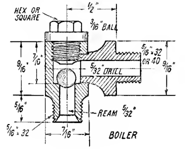
Water-gauge

The top fitting of the water-gauge is made in the same way as described for the oil check-valve, but to the given dimensions; and instead of having a ball-seating in it, it is drilled through with 3/16-in. clearing drill, say No. 11, as the glasses are seldom truly circular, and need plenty of clearance. I have also shown the cap turned

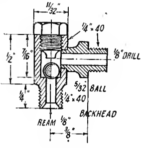
from $\frac{5}{16}$-in. round rod, and squared above the flange, for the sake of variety. For the bottom fitting, chuck a bit of $\frac{3}{8}$-in. round rod in the three-jaw. Face, centre, and drill to $\frac{11}{16}$ in. depth with No. 30 drill. Turn down $\frac{3}{16}$ in. of the end to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40. Part off at 1 in. from shoulder ; reverse in chuck, holding in a tapped bush in the three-jaw. Centre, and drill through with No. 48 drill ; open out to $\frac{5}{16}$ in. depth with No. 30, and bottom to $\frac{3}{8}$ in. depth with $\frac{1}{8}$-in. D-bit. Tap 5/32 in. by 32, and nuts back-to-back, then the other ring. Let the glass drop into place, and screw the nuts home with your fingers, giving them about a quarter-turn with a little spanner ; that is all they need. Never clamp a gauge-glass tightly ; if you don't believe me, ask any full-size driver or fireman—*they know* !

Boiler Feed Clacks for "Maid" and "Minx"

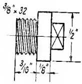
There is no need to dilate on these, as they are



Boiler clack



Backhead clack



Washout-plug

don't spoil the seating. Turn the outside to outline shown. Drill a 7/32-in. hole in the side, at $\frac{3}{8}$ in. from the shoulder ; at $\frac{1}{4}$ in. from the other end, and diametrically opposite, drill a 5/32-in. hole. Fit and silver-solder a $\frac{5}{16}$-in. gauge-glass socket and a 7/32-in. by 40 union-screw as shown. The valve-pin is same as blower-valve pin, but has a cross-handle instead of a wheel, and no gland is required. The gland-nuts are made from $\frac{3}{8}$-in. hexagon rod, same process as union nuts.

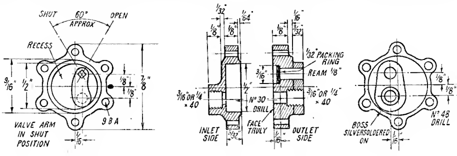
To erect the gauge, drill a 7/32-in. hole in the backhead, between the regulator and blower-valve, in the position shown in the view of the complete outfit, and tap it $\frac{1}{4}$ in. by 40. At $1\frac{3}{4}$ in. below it, on the vertical line, drill and tap a similar hole. Screw in the fittings with a touch of plumbers' jointing on the threads. I always line-up my gauge-glass fittings by putting the shank end of the drill used for drilling the sockets for the glass (No. 11 in this case) through the top fitting, and then adjusting the bottom one until the end of the drill drops into the bottom socket of its own free will and accord. I know then, that the holes are absolutely dead in line, and the glass won't be nipped and broken when tightening-up the gland-nuts. They should not be very tight, as the glass must be free to expand ; and rubber rings should be used as packing. Slip a short bit of rubber tube over a piece of $\frac{3}{16}$-in. steel rod, and try a gland-nut on the outside. If the gland-nut won't go over the rubber easily, chuck the rod in the three-jaw, run the lathe as fast as possible, and hold a bit of fine glass-paper to the rubber. A few seconds of this treatment will thin it down sufficiently for it to enter the nut. The rubber tube can be cut into rings by applying a discarded wet safety-razor blade to the rubber as it revolves. When you push the rubber off the rod, it will fall into rings. Wet the glass and rings ; insert glass through top fitting, put on first a ring, then the

made by the same method described for the oil-clack, the size being given in the illustrations. Two larger ones are needed, and one smaller one. At 2 in. from the smokebox end of barrel on the "Maid," and $2\frac{1}{2}$ in. on the "Minx," drill and tap a hole to suit the thread on the stems of the clackboxes. To get these the same height, beginners should put the boiler temporarily in place on the chassis, mark-off one hole, then set a scribing-block to it, and check the position of the other hole with the scribing-block needle. If anybody sees the engine coming "head-on" and notices one clack higher than the other, you get a blot on your workmanship right away, and I must confess to agreeing with our old pal Inspector Meticulous on that point ! Remove caps and balls before screwing the clacks home ; set them vertical, then apply a brushful of Baker's fluid or other liquid flux around the flange, a small bead of solder, and a blowlamp flame. The solder will melt, flash around, and form a neat seal. You can, of course, silver-solder in a couple of bushes, when on the final brazing job, if you so desire, and screw the clacks into them ; but the 13-gauge boiler shell provides plenty of "hold" for the thread on the stems, the solder seals the joint, and the result is neater than bushing. The backhead clack is screwed into a tapped hole on the horizontal centre-line of the boiler, on the opposite side to the reverse-lever. No soldering is needed here, just a taste of plumbers' jointing. "Doris's" backhead clack is fixed likewise, but there are no side clacks, as she has top feeds, which I will deal with before we erect the boiler.

Blowdown-valve and Washout-plug

At the bottom corners of the backhead, drill two holes with letter R or 11/32-in. drill, and tap them $\frac{3}{8}$ in. by 32, for the blowdown-valve and washout-plug. Both are turned from $\frac{1}{2}$-in. rod, and the plug is just a kiddy's practice job,

needing no detailing. The blowdown-valve is precious little more, being merely a glorified edition of the end of the lower water-gauge fitting, as you'll see by the sectional illustration; but instead of the outlet being screwed externally and countersunk, it is squared off at the end, and tapped for a bit of $\frac{1}{4}$-in. pipe, to take the sludge and residue clear of the "works." Anoint the threads with plumbers' jointing before screwing home.



Casing of "Everlasting" valve

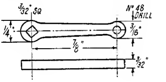
"Everlasting" Blowdown-valve

To those of our fraternity who want a bit of realism combined with a real thunder-and-lightning blowdown, I recommend the type of valve used on big engines, as mentioned last week. The reproduced illustrations and the following particulars are taken from an actual valve, one-sixteenth full-size, made by Mr. F. S. Lovick-Johnson himself; and a dinky little gadget it is, at that. Maybe I'd better explain how it works, first of all, and then you will more readily follow the construction. The body is made in two halves held together by six screws. One half is recessed, and the other truly faced; the recessed half merely has a boss drilled and tapped for the inlet pipe. The faced half has a similar boss drilled and tapped for the outlet pipe; and when the two halves are assembled, both are in line, giving a straight-through "entrance to the way out." Directly above these holes is a reamed and counterbored hole, in which works a spindle, called a "post" by the makers, and a lever is attached to the outer end. The inner end carries a curved arm, which works in the recess. In the lower end of the arm there is a small circular valve, like a round slide-valve, its working face being kept against the faced half of the casing by a weeny spring washer behind it. When the valve covers the lower hole, the outlet is closed; and the higher the pressure, the tighter it closes, because the recess is always full of water under pressure, which keeps the valve on its working face, same as steam pressure keeps the slide-valve in a steam chest against the ports. Moving the lever, turns the spindle, and with it the arm, which slides the valve away from the opening, giving the water a full-bore exit. That is all there is to it; simple, yet effective.

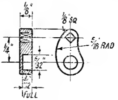
Valve Body

The two halves of the valve body can be made from $\frac{3}{4}$-in. hexagon rod, bronze or gunmetal for preference. Chuck a short bit in three-jaw, face off, and form the recess with a $\frac{1}{2}$-in. D-bit in the tailstock chuck. Cut back with a knife-tool, say 1/64 in., just enough to leave a 1/32-in. ring all around the recess; then part off at $\frac{5}{16}$ in. from the end. Scribe two lines at right angles across the centre of the plain side; then, at $\frac{1}{16}$ in. away from the vertical one, and $\frac{1}{8}$ in. below the horizontal one, make a centre-pop. Chuck in four-jaw with this running truly, and turn the boss. Centre, drill No. 30, open out and tap $\frac{3}{16}$ in. or $\frac{1}{4}$ in. by 40 as required; former for "Doris," latter for "Maid" or "Minx."

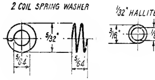
Chuck the rod again, face truly, and part off a $\frac{3}{16}$-in. slice. Rechuck the other way around, and cut back the corners for $\frac{1}{16}$ in., so as to leave a round boss $\frac{5}{8}$ in. diameter, standing up $\frac{1}{16}$ in. File up the oval boss from a bit of 3/32-in. brass sheet, and silver-solder it on in the position shown; this simulates the cast-on boss on the full-sized valves. Maybe our advertisers may supply castings for the weeny gadget. Mark off the position of the two holes on the oval boss, as shown in the illustration. Chuck in four-jaw with the lower one running truly, and drill and tap, same as the recessed one. Rechuck with the upper hole running truly; drill No. 34 right through, and ream $\frac{1}{8}$ in. Counterbore the other end $\frac{3}{16}$ in. diameter and $\frac{1}{16}$ in. deep, with a pin-drill. Drill the six screwholes in the corners



Operating lever

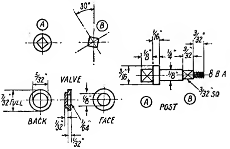


Valve arm



Valve spring and washer

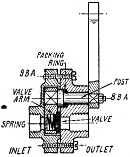
of the hexagon with No. 48 drill, then clamp the two halves together, and locate, drill and tap the screwholes in the other half, same as for a cylinder cover. Put a bit of $\frac{1}{8}$-in. rod through the lower holes, to keep the two halves lined up, whilst doing this.



Spindle or post, and valve

Working Parts

The post, or spindle, is turned up from a bit of $\frac{3}{16}$-in. round rustless steel or bronze rod, to the given dimensions, the lever end being similar to the end of the regulator rod; and you should know how to file squares by this time! The relationship shown between the two squares doesn't matter; it is only given in case any friend or relation of Inspector Meticulous wishes the lever to move the same amount each side of centre. The curved arm is filed up from a bit of $\frac{1}{8}$-in. brass plate, and recessed with a drill and D-bit. The valve is turned from $\frac{1}{4}$-in. round bronze rod. Chuck in three-jaw, face off, recess with a D-bit (just merely relieve the centre, it gives better contact) turn to 7/32 in. full diameter, then with a parting-tool cut in 1/32 in. behind the face, to 5/32 in. diameter, finally parting off $\frac{1}{16}$ in. from the end. Face valve, and the half of the casing, as described for slide-valves and port faces.

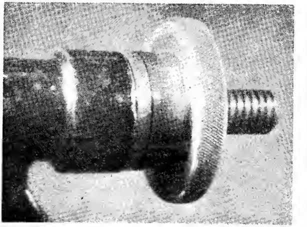


Section of "Everlasting" blowdown-valve

How to Assemble

Fit the curved arm to the end of the spindle. In the recess in the arm, put a tiny double-coil bronze spring washer, as used in radio and similar work, and set the back of the valve against it. Put a 1/32-in. "Hallite" ring in the recess in the spindle hole; carefully insert the post, seeing that the valve is in place when the post is right home; then put on the recessed half of the casing, and screw together by six 9-B.A. screws. The handle is attached, same as the regulator-handle; and for sake of appearance, the casing can be filed up as shown in the illustrations. Piping arrangements to follow later.

A Tailstock Indexing Dial



THE idea of fitting an indexing dial to the tailstock barrel of my lathe occurred to me as being the obvious method to ensure the accuracy essential for many jobs which it was difficult to carry out with the prevailing methods, e.g., the graduating of the barrel, etc. I had not seen or heard of a dial being fitted to the tailstock before, but nevertheless decided to carry out my intention.

I may say that my lathe is a $3\frac{3}{8}$-in. Zyto. I had no trouble in determining a suitable number of divisions, since the thread on the barrel is $\frac{1}{8}$-in. pitch and, consequently, using 125 divisions, I was able to arrive at the graduation of 1 division equal to 1 thou.

From the photograph it will be seen that I have also fitted a new hand-wheel at the same time. Whilst this simplified the fitting of the dial, it was not done with that purpose in mind, but because the thread in the original wheel was a bit worn and the thrust arrangement, being of the split washer type, was not considered satisfactory.

I am convinced that similar dials could be fitted to the majority of hand-wheels without much alteration being made. The dial needs only to be of the fixed type, since it can always be set to zero by moving the tailstock body along the bed. Since using this method, I have found that I can drill holes to a specified depth much quicker than before, at the same time ensuring that they are dead accurate.—R. KEY.

Motorising a 6-in. Lathe

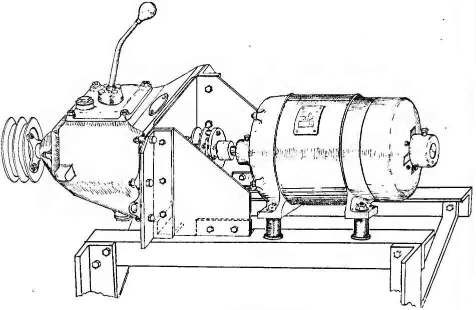
by F. Butler

IN modern machine-shop practice, it is almost becoming the rule to adopt individual motor drives. The line-shafting tradition is slowly dying out, but lingers on in the case of some general-purpose centre lathes, which are still driven by flat belts from stepped cone-pulley countershafts. The objections to flat belt drives are well enough known. They slip, their tension varies with the weather, they are clumsy, slow to change speed, inefficient and frequently need attention.

An Ideal Combination

Endless V-belt drives are a much better proposition, but when speed changes are desired, the usual countershaft design seems cumbersome, even as applied to some of the most modern machine tools. A change-speed gearbox associated with a single-ratio V-belt drive represents an ideal combination and can be applied to an existing machine equipped for flat belt working. These thoughts were very much in mind after the purchase of an ancient 6-in. lathe, in such a condition as to demand complete rebuilding. In fact, its state was so bad that the provision of a new drive seemed only a trivial addition to the total work. It was, therefore, decided to tackle this job first and then to restore the lathe in such a way that it could soon be made to rough out replacement parts, leaving finishing cuts only to be made on such other machines as became available for short periods.

A Crompton-Parkinson repulsion-induction motor, conservatively rated at 1/3 h.p., 1,440 r.p.m. was on hand. Past experience had already shown that it was practically impossible to stall this motor even when taking the heaviest cuts. Quite often, electrically-driven machine tools are overpowered, which is bad practice on two counts; the initial capital cost is unnecessarily high and a lightly loaded induction motor has a low power factor, leading to uneconomic operation, frowned upon by electricity supply authorities who no longer like to sell the stuff.



The electric motor and gearbox assembly

Easily Adaptable

The next step in the conversion was to visit the yard of a transport contractor in an attempt to find a suitable second-hand car gearbox. After some thought, an Austin 7 unit was picked out. Externally, its condition was not impressive, but on taking off the cover, the mechanism proved to be in first-class condition. The unit seemed easily adaptable to the job in hand, so it was carefully cleaned inside and out, then laid aside until the complete design of the drive unit had been planned. Plenty of steel plate and angle was available in the form of a Morrison air-raid shelter

and so work started with this as a basis. The prospects of sawing all of it up by hand were not enticing but there was no alternative.

An idea of the construction finally adopted can be obtained from the accompanying drawing of the power unit. The gearbox is bolted to a stiff built-up bracket which in turn is fixed to a pair of long angle members, extended to support the motor, which drives the gearbox through a flexible coupling. There is little point in giving detailed measurements, since no two installations of this kind will be identical, though a number of operations will be common to the construction of them all. These will now be described.

Mounting the Gearbox

The gearbox mounting flange carries a shallow spigot, normally recessed into the engine housing. This is not required and it must be cut off flush with the flange. A protective sheet of tinplate should be used when sawing, in such a way as to prevent scoring and scratching the flat aluminium alloy flange, after which careful filing is required to true up the whole surface.

Next, cut out a rectangular plate of ⅛-in. or $\frac{3}{16}$-in. steel plate, big enough to cover the gearbox flange, then bore a hole in it to clear the bearing housing at the power intake end. Using the flange as a template, mark out and drill the eight bolt-holes required. It is best to drill these undersize, and then to open them up with a round file to take ⅜-in. B.S.F. bolts. The flat plate must then be stiffened by three short pieces of steel angle, which are drilled to match the plate. The two side members serve for the attachment of stiffening webs, cut from ⅛-in. plate, while the bottom angle piece allows the gearbox assembly to be bolted to the main longitudinal members. Reference to the drawing will make these points clear. In work of this kind it is difficult to mark out and drill the separate components accurately. A simpler procedure is to clamp the parts together temporarily, then drill them while assembled. In this way, clearing size holes are not required, but may be drilled exactly equal to the bolt diameters. The lower edge of the stiffening webs is fixed to the base, again using short lengths of 1-in. × 1-in. angle material held down by ¼-in. bolts.

The Coupling

Having mounted the gearbox in this way, attention can be turned to the flexible drive coupling. With the gearbox is a clutch plate riveted to a boss having a short splined shaft. Chisel off the rivet heads and remove the plate. The remaining boss has six holes and is used to form one flange of the coupling. Machine up a second flange, using a chuck backplate casting, bored to suit the motor shaft and drilled with three holes to match those in the clutch-plate boss. A leather ring should now be cut out, drilled, and six bolts and short tubular distance-pieces used to complete the coupling.

A trial assembly of the motor drive may now be made, temporarily packing up the motor to the correct centre height. In this position, the length of the short columns required to support the the motor above the base may be determined. Four pillars should then be turned to size and drilled axially for the motor foundation bolts, after which, complete assembly of the whole unit is possible.

The Power Drive

Attention may now be turned to the final power drive. In the unit described, twin Fenner V-belts are used (size A.42), two rough-bored stock-size double-grooved pulleys being bought with the belts. The gearbox pulley is bolted to the propeller-shaft drive. It is probably bad practice to apply a side thrust at this point, but the belt tension is not very great and the total power is only a tiny fraction of the gearbox rating. Here it may be observed that there are a few rather obvious points to be noted regarding the installation of V-belt drives. The need for accurate alignment of the pulleys is clearly greater than in the case of flat belt drives, and to ensure long belt life it is essential to use pulley diameters in excess of a certain recommended minimum. The sizes now in use are 4¾ in. and 7⅜ in. respectively, giving a wide safety margin, and allowing for the transmission of 2 h.p. at the mean driving pulley speed of 800 r.p.m. It is always a problem to devise a neat way of fitting a unit of this type to the lathe. In the present case, the bed is supported on two massive A-standards. A long angle member was rigidly fixed by four ⅝-in. bolts, across these standards, at the rear of the lathe and about 18 in. above the floor.

Referring again to the drawing, the top ends of two lengths of steel angle are shown bolted to the front horizontal member. These legs are about 15 in. long and are each drilled near the bottom with a ⅝-in. hole. A short length of steel angle, similarly drilled, is hinged by a loose ⅝-in. bolt to the foot of each vertical leg and is fixed rigidly to the long member which is carried on the lathe standards. The centre height of the motor and gearbox axis is arranged to be just above the lathe centre height. Because the unit is supported unsymmetrically, it tends to swivel backwards away from the lathe, and when the belt is in position, it is found that no other tensioning arrangement is necessary. To stiffen the unit chassis, various cross struts are built in and the rigidity is ample to withstand any normal stress. Finally, the whole structure is sprayed with several coats of grey cellulose enamel to match the lathe finish.

On completion of the work, the gearbox should be filled with flushing oil and run light to clean the interior. After draining, the box should be refilled with a medium grade motor oil.

Speeds

It may be of interest to give the approximate speeds in the various gears :—

3rd gear (direct drive)	1,440 r.p.m.
2nd ,,	800 ,,
1st ,,	450 ,,

A reverse gear of considerably lower ratio is also available and proves to be surprisingly useful.

A great deal of hard work is necessary in making a conversion of this kind, but the cost is little or no greater than the usual countershaft, while its practical convenience and efficiency make the whole effort well worth while.

*TWIN SISTERS

by J. I. Austen-Walton

Two 5-in. gauge locomotives, exactly alike externally, but very different internally

THE foundation for " Major " and " Minor " and, for that matter, any small locomotive, is the frames.

Most small locomotive men get through the frames job without too much difficulty, and produce what they believe is a good set. I don't know just how many hours are spent later on in terms of dismantling in order to put in extra holes for some forgotten parts. The usual method is to dodge the dismantling altogether and to use a small electric or hand drill. This is an admissible method for holes not requiring very exact location, such as running-board brackets and odd pipe clips, etc.; but for precision holes, drilling through the still-bolted-together frames is the only safe way.

On examining the frames drawing for the " Twin Sisters " you will notice that quite a large number of holes are put in. On the drawing you will find only the main dimensions and outline details are incorporated. Even so, there is still quite a maze of dimensions : any more would confuse the builder. It is planned to present the same drawing giving only the dimensions for the holes and their positions. Later it may be necessary to reproduce parts of both these frame drawings to illustrate the positions of certain parts during assembly.

The material required for the frames of the " Twin Sisters " is the same in both cases, as you may wish to embody " Major " features in " Minor " and any simplifications are not yet worth worrying about. Even the little cut-outs in the centres of the frames are easy to make (and true to prototype) and will make the locomotive " look the part."

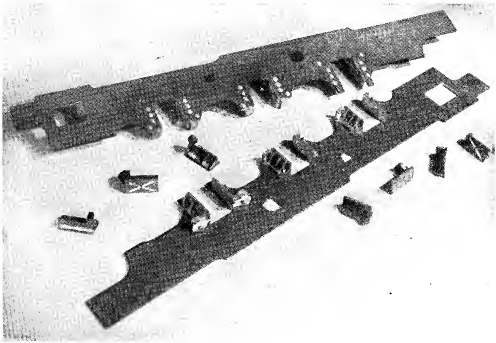


Photo by] *The side frames and horn cheeks* [*A. Duncan*

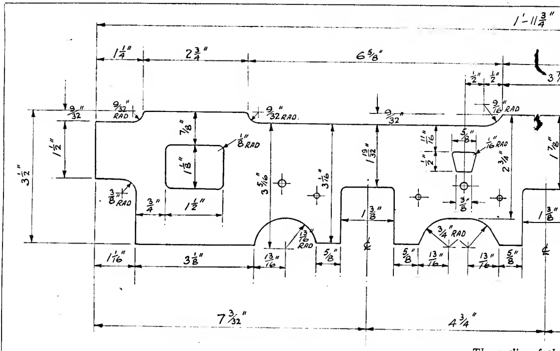
You will require two pieces of $\frac{1}{8}$-in. or 5/32-in. steel plate 2 ft. long by 4 in. wide, these dimensions allowing a small amount for final trimming. It is quite safe for you to use $\frac{1}{8}$-in. plate, because 5/32-in. material is, at present, very hard to get and the system of stretchers for inside bracing will give an unusually strong pair of frames.

On the question of the type of steel to use, the usually-favoured planished plate is not the ideal material. The failing with practically all the bright-finished steels lies in the cold finishing process which locks up much more stress in the metal than is found in the black steels sent out

*Continued from page 84 " M.E." January 20, 1949.

with the hot scale still on them. The bright steel, when cut, tends to release its stresses and distorts in the process. The remedy usually suggested as a cure for the trouble is to hammer the section opposite the affected side, that is to say, if an axlebox cut-out spreads at its open mouth edge, then, by hammering the bridge of metal over the opening, you again draw together the sides that

beautiful frames. It was easily distinguished from the other material by its hard, shiny and very even dark blue scale, and always it was flat and without twist or wind. I have distinct recollections of its refusal to distort even when cut into elaborate forms and its natural springiness allowed for local and temporary stresses that never left any permanent " set."



The outline of the

have been spread apart. This remedy works quite well and is, in fact, one of the few remedies that can be applied where the component has already been cut and finished to size. To my mind, however, this must always be a negative form of cure, in that it corrects the distortion by putting into the material fresh stresses that may, one day, come out. Apart from that disadvantage, it is difficult for the average man to hammer steel plates without leaving dents or hollows and, at a later date when some bracket or port has to be bolted on the frames, it is found that it won't sit square on its seating, owing to the locally belaboured patch. I have had to do that myself in days gone by, and suffered the disadvantages just enumerated.

There is still another disadvantage to be found in the use of planished steel, and that lies in a much later process—painting. Bright steel is not the best material to provide a key for the paint, whereas the black steel responds very well, and doesn't show those tell-tale patches where the paint almost inevitably is worn or knocked off.

Years ago, I would go into one of the big London steel warehouses and ask for a sheet, of double-shear steel. There are two grades—single and double shear—and the latter made

Although I have not tried to get any of this steel recently, I have an idea that it might now be " out of stock " or no longer made, or it may still be made under another name with some S.A.E. specification number tacked on to it.

Two pairs of frames for the " Twin Sisters " have now been made and both are completely successful. My own trial set is made in 5/32-in. stainless steel, sandblasted in the sheet form before being cut out in order to give a good paint " key." The other set has been made by a friend of mine, Mr. A. Duncan, who is manfully following these instructions (a little in advance) and who lives close by. He is bound to figure in these talks quite a good deal as time goes on ; the photograph of the frames is actually his set and not mine. These are made from " shelter top " 1/8-in. material, specially selected, and you can see from the photograph that they come well up to standard for looks. Mr. Duncan is, in a sense, a little dependent on me for this particular locomotive experiment, and let us here and now pay tribute to him as a pioneer in the adventure ; he will, I hope, find out my mistakes some time before my readers do, so that his engine will be the only one spoiled, and mine and yours will go ahead unharmed.

My own frames, in stainless steel, presented no difficulties in terms of cutting out, filing and drilling, and took no longer to complete than if they had been made in mild-steel. Similar frames may work out a trifle expensive unless you happen to know of a cheap source of supply. I was lucky in that respect and I mention this just in case some person reading these notes happens to be in such a fortunate position, either for himself or for the benefit of other readers. As a general rule, you will find the filing of stainless steel quite a pleasant occupation and not unduly hard on the files. With slow, even strokes, metal is removed quite quickly and the filings seldom, if ever, clog the teeth of the file.

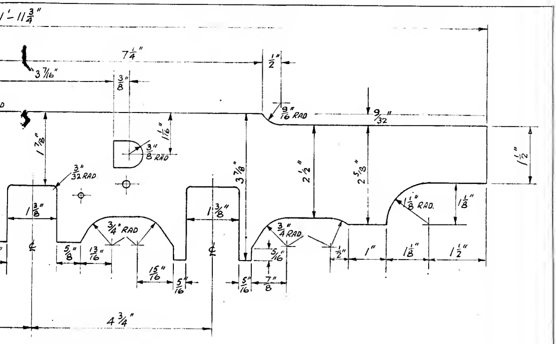
Whichever material you decide to use, or are able to obtain, should be inspected for initial faults such as "twist," "wind," bends and local damage. If your blanks have been cut on lever-type shears you will certainly find "twist" and this must be removed before any bends are eradicated.

I deal with twist in the following manner. If it is apparent and evenly distributed down its length, place one end in the vice, holding not much more than ½ in. in the jaws. By looking down the plate from the opposite end it will be possible to see which way the plate turns. A large adjustable spanner or one of those old-fashioned wooden-handled "monkey wrenches" screwed up tightly on the other end, may be used to twist the sheet in the opposite direction. Generally it will be found that the correcting twist has to be taken some way past in the opposite direction in order to let the natural spring of the metal return it to its desired position. A few trial twists will soon show how much "over-twist" is required.

If the twist is a local one, with a certain amount of flat and even plate before it, then hold the flat portion in the vice, close to where the twist begins, and carry on as described above. It stands to reason that a very local central twist would call for holding in the vice just before the twist and the placing of the spanner just above it, not at the extreme end of the plate.

Bends are located by looking directly down the edge of the plate and by placing a finger on the obvious kinks one by one before looking up from the "sighting" operation. Chalk-marks record these places, which should be marked one at a time and corrected in the same manner. Holding the plate in the vice and pulling with a spanner is far preferable to the use of a hammer; but, if the metal is too stout to yield readily, try pulling with the spanner and "helping" round with a copper or rawhide hammer. At least, you won't get dents and jags, and local stressing will be eliminated. All this may appear to be labouring the point to extremes, but, unless the frames are right to begin with, you will meet trouble after trouble all through the job and hidden and forgotten faults will haunt you from "layout to driving-day." So just get them right in every respect—and enjoy a good night's sleep!

Having got two pieces of plate free from "twist," bends and other faults, and that will lie flat on each other whichever way round they are placed, you can get on with the marking-out process.



ine of the frames

If the plates are black steel, you will require a light-coloured ground to make your scribed lines visible. A good, quick-drying white or yellow paint, applied thinly and very well brushed into the metal, will do quite well, provided you are prepared to let the coating dry thoroughly. The time-honoured method of chalking the steel is all very well for jobs that are not going to hang about or get much handling, but locomotive frames are not likely to fall into this category, and a more durable coating is to be desired.

If the frame metal is bright, or has been sand-blasted to remove the scale and prepare a good surface for painting, then a dark coating is the order of the day. There are special preparations on the market, and one of these—"Spectra-colour"—I have tried and found to be excellent. This is a coloured spirit that dries evenly and instantly, and apparently does not chip or break away near a scribed line, nor does it appear to be affected by a lubricant when machining close to marking-out. I have also used a home-made preparation that does the job very well, and this can be made up in a few minutes and for just a few pence. The prescription is as follows :—Methylated spirit, $\frac{1}{2}$ pt. ; ordinary flake shellac, 1 oz. (or thereabouts), enough spirit-soluble stain or dye to give a good solid colour. The mixture I am using at the moment is coloured with the contents of a couple of sixpenny packets of "Hermine" brand mahogany spirit stain bought at my usual paint shop. The resultant brew, applied not too thickly with a bit of rag, does the trick quite well.

Having got a suitable marking surface prepared, scribe a straight line representing the top edge of the frame, disregarding the shallow cut-outs, and make sure it *is* straight. The luxurious fellow will probably mill this out on both blanks clamped together, but it is almost as easy to file this first time and, by doing one plate at a time, the two resultant edges can be tried out one against the other, occasionally turned end for end, and again tried as a check for straightness. When the two plates meet exactly, however offered up one to the other, it can reasonably be supposed that they are straight.

This top edge is going to become the "horizontal datum line" for all measurements from top to bottom of the frames. Next, you square off one end of both plates from the top straight edge and this becomes the "vertical datum line" of the frames. Make this the front edge (left of the drawing).

Now you can mark out all the main dimensions, starting from the main overall length and depths of the frames *where the dimensions are taken from the top edge.* Follow on with the main axle-centres where the axlebox cut-outs are placed, then the dimensions giving the outside profile all round the frames. Finally, mark the "enclosed" cut-out portions (there are three of these). You will find some minor dimensions marked off from the opposite end to the "master" or vertical datum end at the front. It is safe to do this, as they do not control the positions of any working parts, and merely complete the outline of the frames. You will also find a number of dimensions not taken from the top edge but from the lower line of the finished profile in some places, but, as this lower line is exactly 9/32 in. lower than the top, or horizontal datum line in every case, it is easy to add this figure to the dimension affected. You may wonder how to scribe the various radii in the outside profile, as the divider point will be in "mid-air" or outside the plates being marked, but, by clamping down the plates to a piece of wood, the divider point can be positioned outside the work and tried until the sweep of the scribing point strikes the correct arc. In every case, you will find correcting dimensions preventing you swinging this line too far in or out, and a little careful study of the drawing will reveal them easily enough.

If any distortion is going to take place, it will occur where the largest cut-outs are made ; that is, the places where the axleboxes will reach well up into the section of the frames. Therefore, cut these out first, and then check up the top edges of the frames to see if anything has walked out of line. It is advisable to work on both frame blanks bolted together. Drill a hole in each of the two cut-outs in the middle of the frames—the square one in front and the D-shaped one just past the middle. Two good-fitting bolts, about $\frac{1}{4}$-in. diameter, will act as service fixings until the last stages where these cut-outs will be completed. By then you will have dimensions of the other holes in the frames (not shown in this drawing) and two other suitable holes can be selected.

I hope you are going to take quite a lot of care in carrying out this foundation work and that you won't skip the little radii shown in the axlebox arches, or make them bigger than shown ; if you do, you will have trouble in the fitting of the horn-cheeks. It will pay you, also, to make a little plate gauge—a bit of $\frac{1}{8}$-in. plate will do—filed exactly to $1\frac{3}{8}$ in. width and with its sides quite parallel. You can then use it to to get all three arches uniform.

Endeavour also to treat the frames with the respect they deserve and avoid stamping the bench vice "trade mark" all over the surface at every fresh holding. If you haven't got brass "clams" or a vice with smooth jaws, make some, for you will be needing them all through the job.

When you have got so far and completed the first drawing you can separate the two parts and, with a smooth file, work down the rag and burrs of filing. Whatever you do, avoid any over zealous flourishes of the file likely to produce a distinct chamfer on the edges. This is fatal, and shows up to the bitter end, even after painting.

You can also carry out a final inspection of your work, checking up all measurements and positions, so that further progress can be made with complete confidence and the knowledge that you have a really good job, correct dimensionally and structurally and worthy of all the other bits and pieces that will presently take up their positions.

If the job is right—pass it. If it is not, don't go on, even if you have to make a new pair of frames, for the trouble you may encounter later will be greater than that of making a fresh start.

I know, I've done it myself!

(To be continued)

*The "Eureka" Electric Clock

by "Artificer"

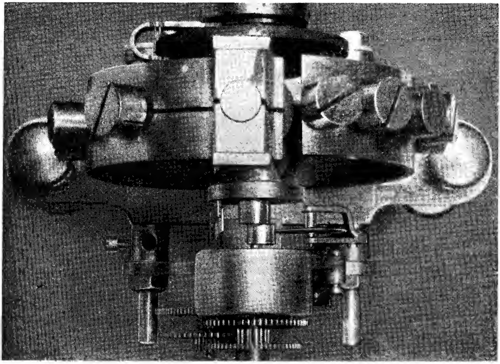
FOR the benefit of readers who may wish to construct a clock of this type, or one working on similar principles, some details are given here of the essential working components, with main dimensions, and other useful data, though no attempt has been made to give working drawings which are complete in every respect. It is more than likely that any constructor who undertakes to build such a clock will wish to introduce minor modifications of his own design, or possibly to utilise existing material, such as gear wheels or other clock parts ; and so far as possible, advice will be given regarding the deviations from the set design which are permissible—or even, in certain cases, desirable.

Balance Wheel

The balance mechanism of this clock is the heart of the entire functional system, and also the most difficult, or at least the most complex, part of the clock to construct. As the balance wheel contains the windings of the electro-magnet which provides its motive power, and it is not practicable to wind it *in situ*, it is necessarily a built-up structure, the several parts of which must be assembled in such a way that the whole runs truly on its pivots. This demands great care and accuracy in machining and fitting the parts.

As will be seen from Fig. 4, the main structural items comprise the round core and two flat side plates of soft iron, which pass across the centre of the wheel, and are joined at their outer extremities by clamp blocks, to which are attached the two parts of the split bimetal rim. The pivots are mounted in flanged brass cheeks, attached by screws to the two side plates. It is recommended that the mechanical part of the structure should be completely built up and machined before dealing with electrical parts, the winding being done separately and fitted afterwards. This, of course, entails dismantling and reassembly of the wheel structure, but having once correctly machined and assured the true running of this component, it will not be too difficult to set it true on final assembly.

The side plates are $\frac{7}{16}$ in. wide by 3/32-in. flat



Plan view of "Eureka" clock, showing eccentric and roller-operating ratchet lever

*Continued from page 130, "M.E.," February 3, 1949.

strip, and the core piece $\frac{5}{16}$ in. diameter round bar, specified as soft iron, but as it may be somewhat difficult to obtain the Swedish "charcoal iron," which is generally represented as the ideal in the electrical text books, it may be mentioned that mild-steel has been found to work quite well for small electro-magnets in which high permeability and minimum retention of magnetism are essential properties. To ensure that it is as soft as possible, it is advisable to take the precaution of annealing it, which in the absence of a muffle or other heat-treatment equipment, is best done by packing the material inside a piece of iron pipe, in lime or ashes, with iron or clay plugs in the ends, and heating the lot up to a bright red, sustaining the temperature for several minutes and then allowing it to cool off naturally. The traditional use of the kitchen stove, and the all-night period of cooling, cannot be improved upon for this operation.

By heating the metal in an enclosed chamber so that it is protected from the atmosphere, little or no scaling or pitting of the surface should take place, but the metal should in any case be cleaned up, and trued if necessary, before proceeding further. It may here be mentioned that it would be an advantage, from the structural point of view to modify the shape of the side plates, making them at least as wide as the diameter of the brass cheeks ($\frac{7}{8}$ in.) in the centre, and tapering off to $\frac{7}{16}$ in. wide at each end. This would allow of using three screws for securing each of the cheeks. Better still, the plates may be made wider in the centre than the diameter of the cheeks, and thick enough to allow of turning a recess to register tightly over the latter, thereby improving the rigidity of the assembly considerably. Leave a small allowance on the length of the plates for finishing.

Mark out the positions of the centre pivot and the two clamping screws on one of the plates, taking great care to ensure symmetry in both planes, and drill undersize pilot holes; the second plate is jig drilled from the first, and marked to show relative positions for subsequent location. Next make the two clamp blocks, one in iron and the other in brass; their final dimensions are $\frac{3}{8}$ in. by $\frac{7}{16}$ in. by $\frac{13}{16}$ in., but they are best left oversize on all dimensions at first. Set up each in turn in the four-jaw chuck, crosswise, and drill and ream to a tight wringing fit on the round core piece; if the only reamer available produces too easy a fit, it is worth while to make a slightly undersize D-bit from silver-steel for this purpose. Press both the blocks on to a mandrel, or on the core itself, and finish the end faces by filing or machining so that they are exactly parallel to the mandrel and equal in distance from it on each side.

The blocks should now be set in their correct positions between the side plates, with the core piece in position and the holes for the clamping screw drilled through clamp blocks and core, but not to finished size at this stage. Remove the blocks, and tin one end face of each, also the mating surfaces on one of the plates, and sweat them in position; note that this must be done on one plate only as the other must always be capable of removal. The assembly should be clamped together, with the core in place, and temporary screws or dowels in the holes, while this is being done.

Next dismantle the parts again, and set up the one side plate, with the blocks clamped thereto, on the faceplate for machining the inner concave surface of the blocks to fit the rim of the balance wheel. The centre hole in the plate, for the insertion of the pivot, must be set dead true, and to facilitate this, a temporary plug may be inserted in the mandrel socket and turned down in place to form a close-fitting pilot or spigot. If the sweated joint is relied upon to hold the clamp blocks, very light cuts should be taken on the latter to avoid the risk of their becoming detached; but this risk can be very much reduced if temporary screws are used in the clamp screw holes, and further security may be provided, if desired, by dowelling the blocks in position as well.

The Bimetal Rim

As most readers with horological knowledge are aware, the object of using a split rim made of two dissimilar metals for the balance wheel of a clock or watch is to compensate for temperature errors in timekeeping. The principle is exactly the same as the bimetal strip used in thermostats and "blinkers" as extensively used in electrical apparatus, and it is probable that the idea of these devices was evolved from the methods which had long been used by horologists.

If the rim of a balance wheel is made of solid metal, it is, of course, subject to expansion and contraction with any change of temperature, and thus minute alteration of its diameter takes place, involving similar changes in its radial centre of gravity, or in other words, the moment of its mass. The ultimate result will be that an increase of temperature will tend to slow the clock down, and a decrease of temperature will speed it up. This effect might be very much reduced by making the rim of a metal having a very low coefficient of expansion, such as Invar steel; but long before metallurgists had hit upon this solution, the problem had been dealt with in another way by the ingenious makers of clocks and watches.

In the normal "compensated balance," the rim is made of two metals which have definitely (not necessarily widely) different coefficients of expansion, the one having the greater expansion being on the outside. Brass and steel are common metals conforming to this condition, and are commonly used. The rim is supported by radial spokes, not more than two or three in most cases, and is split near each spoke, so that the composite rim is virtually in separate sections, each forming a curved strip of the two metals in close intimate metallic contact. When changes of temperature take place, expansion or contraction of the spokes of the wheel alter the moment of mass of the rim at the point of support, but this is counteracted by the behaviour of the bimetal rim sections, which alter their curvature by reason of the differential expansion of the two metals. As the spokes of the wheel expand radially outwards, the free end of the rim curves inwards, and if the wheel is suitably designed, the result is to produce a reasonably exact temperature compensation within the range normally encountered.

Having explained the principle on which the rim is designed, we may now proceed to deal with its construction. The first thing to consider is how the two parts of the rim should be fastened together. Intimate and permanent contact are most essential, and it may be remarked that in the manufacture of precision watches, the normal procedure is to make the spokes and the steel inner portion of the rim in one integral piece,

Should the constructor be satisfied with the standard of accuracy obtainable without temperature compensation, a solid rim may be used, preferably of steel having the minimum expansion coefficient, and in this case the subsequent splitting of the rim will not be necessary.

When finishing the machining of the rim, it is essential that the joint line should be maintained in concentric truth, so that the bimetal

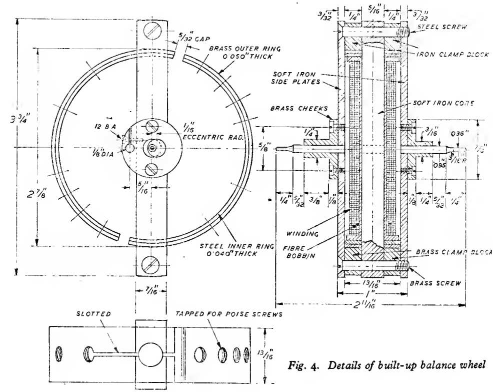


Fig. 4. Details of built-up balance wheel

machined from the solid, and fuse the brass rim on the outside of it. This virtually amounts to casting and brazing on the brass rim at one operation.

It is hardly practicable to adopt this procedure in so large a wheel as we are dealing with here, especially as the spokes cannot be made integral with the steel part of the rim. The next best thing to do is to turn up separate brass and steel rims and silver-solder them together, with allowance for finish machining on outer and inner surfaces respectively. It is essential that the solder should flow perfectly all over the joint surface and no gaps or faulty adhesion patches be left; this should not be difficult if sound methods are employed, but constructors who are not confident of their ability to carry out this work may be prepared to take a chance with soft soldering or "sweating" together of the rims. The surfaces should be very carefully tinned all over and the fit should be close so that little solder need be used.

strips are of even thickness. The brass and steel rims, it may be noted, are of different thickness, and these dimensions, in conjunction with the length of the arcs of the rim, are presumably designed to give correct compensation. The completed rim is finally sweated in position between the clamp blocks, and the truth of the assembly checked. If possible, additional security of fixing should be provided by fitting screws or dowels. It will of course be necessary to follow through the radial holes in the clamp blocks, into the rim at each side, and ream right through to take the core. Do not cut the gaps in the rim at this stage.

The brass cheeks for mounting the pivots may now be turned up and drilled through the centre at one setting, then parted off and set up on a pin mandrel to face the inner side of the flange. Note that one of the cheeks has an eccentric machined on its hub, but if desired, this may be made as a separate piece, grub-screwed to the

(*Continued on page* 208)

*B.H.P. Tests on Petrol Engines

by R. E. Mitchell

IT was originally intended to use a gear oil pump but, when partly completed, it had to be scrapped due to machining errors. After this experience a gear pump of such a small size was not considered to be a very practical proposition. The final design was based on the oscillating pump used by Mr. Westbury for his Kittiwake. The pump body and cylinder were machined from duralumin. The piston of $\frac{1}{8}$ in. diameter was arranged to give a stroke of $\frac{3}{16}$ in. and was of heat-treated silver-steel. The 15-tooth wheel was machined as a plain spur gear. The accompanying worm being $\frac{3}{4}$ in. diameter, it was not thought necessary to hob a worm-wheel, and the duty is only of a light nature. The gear wheel and $\frac{5}{16}$ in. diameter crankshaft are in one piece, and the crankpin consists of a piece of 16-gauge piano wire driven into a longitudinally drilled hole, arranged to give the required eccentricity. Owing to lack of space a leaf spring had to be used instead of the usual helical spring to retain the cylinder on to the port face. All the ports are $\frac{1}{16}$ in. diameter. The pump is secured to the timing case cover by three 8-B.A. screws and the delivery port is arranged to coincide with a similar hole in the cover, communicating with the plain bearing. By this means no external piping is used. A hole is drilled edgewise into the timing cover to communicate with the bearing, to act as a tell-tale for the pump, and is closed with a 6-B.A. duralumin screw. This is plainly visible in the various photographs. A small piece of plastic tubing is attached to the pump inlet although normally the pump is drowned.

Owing to unsuccessful attempts to obtain a suitable magnet at the time a finished instrument was purchased from Model Ignition and Accessories Co. This was of the earlier plain bearing type and on the advice of the manufacturers the magneto is arranged to be driven at engine speed. This, of course, wastes a spark at the end of the exhaust stroke, but is done to ensure adequate starting speed. Since a separate magneto is being used a universal joint was required for the drive. The type decided upon consisted of dural body with two diametrically opposed steel driving pegs driven into longitudinally drilled holes at suitable centres. Two such components are used, one on the engine shaft, which had been reduced to $\frac{1}{4}$ in. diameter for the purpose, and the other, on the magneto spindle. Connection between the two is made with the aid of a $\frac{1}{16}$-in. thick disc of bakelised paper, around the periphery of which, are machined four equally spaced radial slots to engage the two driver and two driven pegs. This type of coupling compensates for both slight angular and axial malalignment and has given excellent service. The remainder of the ignition

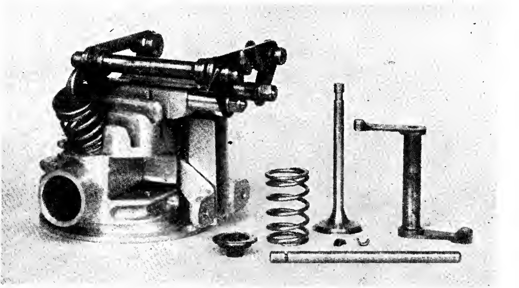


Fig. 13. *The cylinder-head with one valve assembly removed. Since this photograph was taken a second spring has been fitted to each valve*

*Continued from page 174, "M.E.," February 10, 1949.

equipment consists of a Wico Pacy 38s ($\frac{3}{8}$ in. $\times$ 24 t.p.i.) detachable sparking plug which has been found to be very satisfactory.

The engine was erected, all joints in which are metal to metal. Starting was found to be particularly easy on the usual alcohol/benzol fuel.

elasticity of 10×10^6 lb. per sq. in. A gap of 0.001 in. in the cylinder head joint would give rise to serious leakage of the same order as that observed, and will serve as a basis for a calculation of the explosion pressure required to elongate the studs by this amount.

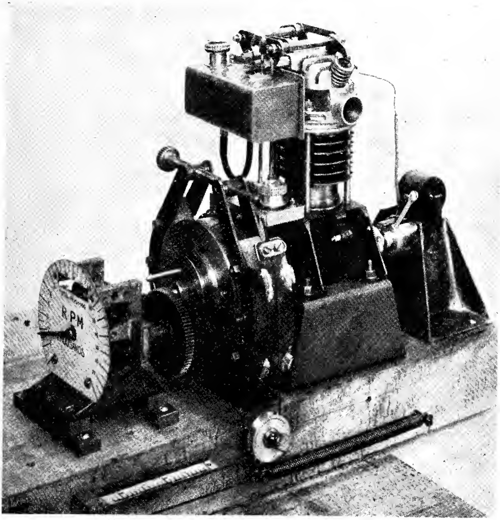


Fig. 14. The engine set up for power output determinations

When running at high loads on large throttle openings considerable leakage was noticed at the cylinder barrel-cylinder head joint, although no leakage could be detected when stationary. The leak was evidenced both by the noise and the large quantities of oil rejected at this joint. The duralumin holding down studs of the previous design had been retained. These were reduced to 0.135 in. diameter between the threaded ends and the trouble was found to be due to elastic elongation of these studs which are $2\frac{1}{2}$ in. long. A good quality duralumin has a modulus of

Diameter of studs = 0.135 in.

Length of studs = 2.5 in.

Cross sectional area of the four studs = $4\pi \; 0.0675^2$ sq. in.

Load to give 0.001 in. elastic elongation

$$= \frac{10 \times 10^6 \times 4\pi \times 0.0675^2 \times 0.001}{2.5} \text{ lb.}$$

Area of cylinder bore = $\pi \; 0.535^2$ sq. in.

$\therefore$ Cylinder pressure =

$$\frac{10 \times 10^6 \times 4\pi \times 0.0675^2 \times 0.001}{\pi \times 0.535^2 \times 2.5}$$

$= 255$ lb. per sq. in.

This is quite a reasonable value that may be attained in an i.c. engine cylinder and is an indication that more power can be expected from the redesigned engine, since similar leakage had not been noticed when using the lower compression ratio.

To overcome this difficulty the duralumin studs were replaced by 0.161 in. diameter studs in 3 per cent. nickel steel. The modulus of elasticity of this material is of the order of 30×10^6 lb. per sq. in. Calculating as before the pressure to give 0.001 in. elastic elongation will be :

$$\frac{30 \times 10^6 \times 4\pi \times 0.0805^2 \times 0.001}{\pi \times 0.535^2 \times 2.5} = 1088 \text{ lb. per sq. in.}$$

Hence the new studs should take care of any pressures which may be developed in the cylinder.

A further weakness in the design also showed itself. From the original power curve it will be seen that the horse-power drops very quickly above 10,000 r.p.m. This was later proved to be due to valve bounce and also showed itself in the present design although at a slightly higher speed. The bounce can be detected by quite a decided change in the character of the blurr produced by the end of the valve stem when running, and is also accompanied by a sudden increase in valve noise. (When testing the engine, a fairly efficient silencer is used.) The exhaust valve was the worst offender although both valves and springs are identical. This is probably due to the exhaust valve closing during a descending piston while the reverse is the case with the inlet valve. The loads required to compress the valve springs were determined and found to be 4 lb. with the valve in the closed position and 6 lb. with the valve fully open. Without fitting new valve guides and spring retainers a stronger spring could not be fitted. To overcome this difficulty it was decided to fit a spring of smaller diameter inside the existing springs. This could be done without any structural alteration. These springs consisted of 20-gauge piano wire cold wound to $\frac{1}{8}$ in. pitch, and a free length of $\frac{3}{4}$ in. on a 17/64 in. diameter mandrel. The loads required to compress the composite springs was found to be 7 lb. with the valve closed and $10\frac{1}{2}$ lb. with the valve open. To eliminate valve bounce, the use of two springs of differing natural periods is to be preferred to one spring of similar load/compression characteristics. On retesting with the new cylinder-head studs and valve springs, the cylinder leakage was found to have been eliminated and an engine speed of 15,000 r.p.m. could be easily attained. A further increase in the valve spring loading would most probably result in overloading the valve gear. During these initial trials, which were in the nature of running-in before final testing, a pressure gauge was connected to the oil pump tell-tale. The following pressure readings were obtained using Mobiloil Arctic oil.

Engine speed r.p.m.	Oil pressure lb. per sq. in. Cold engine	Hot engine
3,000	31	14
5,000	43	20
9,000	45	31
14,500	—	41

These figures are considerably higher than were expected and the gauge was checked and found to give a correct reading. It was found not to be very practical to measure the actual oil temperatures. It was found that the engine started extremely easily and fears that the miniature magneto would not be able to deal with the higher compression ratio were unfounded. The sparking plug also appears to withstand the more arduous conditions equally well. It should be noted that only alcohol fuels have been used, the use of petrol having been proved inferior in this type of engine. The completed engine, as shown in Figs. 9, 10, 11 and 12, weighs 3 lb. 12 oz. without fuel or oil. This is made up of the following weights of the components :

Crankcase	15 oz.
Crankshaft assembly as shown in Figs. 3 and 4	17 oz.
Cylinder-head complete as in Fig. 13	6 oz.
Cylinder	7 oz.
Flywheel	9 oz.
Fuel tank and carburettor	3 oz.
Total	3 lb. 9 oz.

This figure does not include nuts, bolts, studs, etc.

An attempt was made to use the existing dynamometer for the power output tests but this was found to be impossible, due to serious vibration, which occurred at about 7,000 r.p.m. To overcome this it was decided to replace the flywheel with a brake drum of similar diameter. New brake shoes had to be made, and are of the same type as the previous ones with the exception of the method of securing the load cord. The straight torque arm was replaced by a curved plate to ensure that the load is always applied at a constant radius, thus making subsequent calculation easier. The original revolution counter is used and driven as in the previous tests. The whole apparatus as set up for testing is as shown in Fig. 14. It will be noticed that the cord connecting the calibrated tension spring with the brake has been taken over a second pulley. This is done to concentrate the tachometer dial and spring extension scale, so making reading easier. The actual power determinations were carried out without trouble and the results are shown in Fig. 15. During each reading the carburettor needle and ignition advance were adjusted for maximum performance. It was noted that the ignition advance for maximum power is 20 deg. to 30 deg. before top dead centre as against 35 deg. to 45 deg. for the previous design. This is most likely due to the use of a considerably more compact combustion space so reducing the distance which the flame has to travel. It should not be overlooked that a magneto has replaced the original coil ignition system although this should not result in this difference. During the tests the engine behaved perfectly and showed no tendency towards detonation or pre-ignition, although a somewhat higher cylinder-head temperature was reached. The maximum value obtained of 1.52 h.p. at 12,500 r.p.m., with a silencer, will most likely be exceeded when fitted with a tuned exhaust pipe to take advantage of the valve overlap.

It is regretted that no means of motoring the

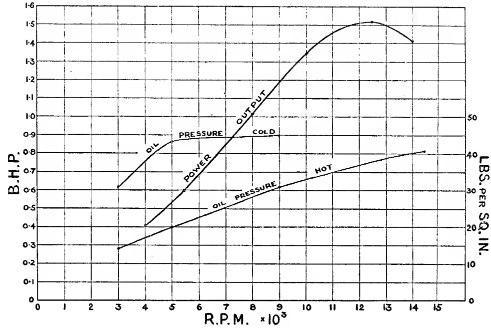


Fig. 15. Power output and oil-pressure curves

engine are available to enable the mechanical efficiency to be determined. The brake mean effective pressure may be calculated, however, from the above information.

B.M.E.P. =

$$\frac{\text{B.H.P.} \times 33{,}000 \times 2 \times 4 \times 12 \text{ lb. per sq. in.}}{N\pi D^2 S}$$

N = Rotational speed r.p.m.
D = Engine bore in.
S = Engine stroke in.

$$= \frac{1.52 \times 33{,}000 \times 2 \times 4 \times 12 \text{ lb. per sq. in.}}{12{,}500 \times \pi \times 1.07^2 \times 1}$$

= 107 lb. per sq. in.

This figure is somewhat higher than that obtained in standard car and motor-cycle engines although lower than that obtained in aircraft engines and indicates a reasonable mechanical efficiency.

On examination, the thinner oil appears to lubricate the engine in a satisfactory manner and it is difficult to understand why such a viscous lubricant such as castor oil is used for small i.c. engines. One experience with a 6-c.c. two-stroke showed that a thinner mineral oil gave better results than castor oil, and resulted in a much cooler running engine due, no doubt, to lower energy required to shear the film of oil. This energy must be dissipated in the form of heat. In another case an engine refused to start until a few drops of castor oil were admitted to the cylinder. Here it was a case of poor workmanship.

In conclusion, the advantages of developing an engine should be stressed. It is preferable to remedy the known shortcomings of a promising design than to attempt a completely new design. In the present case it has taken three years to evolve this design and none of the original engine now remains except the carburettor, fuel tank and starter pulley. When originally constructed the cylinder-head was the weak point and was replaced by the present cylinder and cylinder-head. The crankshaft was then found to be unsatisfactory and was replaced to form the present engine. The very simple carburettor is not as satisfactory as it might be in that full throttle openings can only be used with comparatively high engine speeds.

To Prevent Tools Rusting

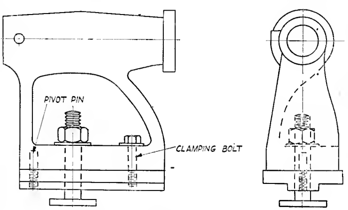
AFTER use, brush the tools over with a solution of vaseline in petrol. It quickly runs over the whole surface, the petrol evaporates, leaving an impalpable film, which keeps tools bright for long periods, even under bad conditions. The solution can be made in such strength, up to a saturated solution, as conditions require.

—R. A. VAN VESTRAUT.

IMPROVING A TAILSTOCK

by C.H.

THE tailstock of the lathe I recently purchased is presumably meant to be of the " set over " type, but the method of construction is, to say the least of it, peculiar. It consists of a soleplate, guided by the inner-ways of the bed, with the tailstock secured to the soleplate by means of a pivot-pin at the front end and a clamping-bolt at the rear, the whole, sole plate and tailstock, being secured to the bed by means of a " T "-bolt and nut. The pivot-pin is screwed into the soleplate and engages in a hole in the tailstock; the tailstock can thus be swung about the pin, subject to the clamping-bolt at the rear, which restrains any excess movement to the limit of the elongated hole in the tailstock. " Set-over " is presumably meant to be accomplished by slackening the clamping-bolt, swivelling the tailstock by hand about the pivot-pin the requisite amount and re-clamping. This is mechanically unsound, as the centre hole in a piece of work " between centres " would not bear truly on the back centre, unless, of course, the tailstock spindle, when adjusted to turn parallel between centres, happened to be parallel to the front edge of the bed. I swivelled my tailstock about until by a " clock " held in the tool-post the spindle was parallel to the front edge of the bed, the centres were now brought together and it was discovered that the tailstock centre was about $\frac{3}{16}$ in. out of line with the headstock centre. To rectify this colossal error, my remedy was to remove the pivot-pin, line up the tailstock and depend on the clamping-bolt to keep in alignment and not bother about taper turning. For good clean healthy fun I can recommend the execution of the simple work mentioned in the last sentence; it provides weeks of amusement, but as long as you realise the state of mind you are getting into and " chuck it up " before being carted off to a padded cell, no great harm is done.



Elevation and end view of the original tailstock

The procedure I adopted was as follows :—

Remove pivot-pin.

Insert centres in headstock and tailstock spindles, run tailstock spindle out and set it parallel to the front edge of the bed by means of a clock in the top slide, hold firmly and tighten clamping-bolt—check again by the clock, usually to find that the tightening down has moved the spindle out of alignment with the front edge—three attempts usually got the clock " running " stationary as it travelled along the spindle. Put a piece of metal between centres and machine half its length, take " mike " readings at the machined ends and the difference is the amount the tailstock is to be set over to enable the lathe to turn parallel. Slacken the clamping-bolt and move the tailstock bodily over the requisite distance — that " bodily " is the amusing part. Assuming the difference in readings to be 10-thou. my procedure was as follows :—

Hold the tailstock firmly against the soleplate with the left hand and slacken the clamping-bolt with the right, grasp the tailstock with both hands and push forward (or pull back) bodily the requisite 10 thou.—one small difficulty was pushing forward 10-thou. and even assuming that one was lucky enough to push 10 thou. with the left hand, it was always 5 thou. more or 5 thou. less that I invariably pushed with my right hand. This, of course, resulted in the spindle being no longer parallel to the front edge of the bed, so I started all over again.

Over a period of weeks I several times nearly got the correct position, but, of course, I wanted it " spot on." Eventually I reached the state when I found myself looking at a large hammer and thinking that one hefty clout from it would put paid to that so-and-so tailstock. Giving vent to one's feelings in this manner would lift the safety-valve, but be rather costly financially—the Scottish streak in me won and the mental resolution was " one more try and whatever the result—leave it." The last effort resulted in the spindle being at a slight angle to the alignment of the front edge of the bed. By advancing the spindle about $1\frac{1}{2}$ in. by the handwheel, anything between centres turned " near enough " parallel, but when it came to drilling from the tailstock it was another story. The drill had to be sprung over to get it started, and as soon as it had reached a depth of $\frac{1}{2}$ in. it would

start binding and screaming until eventually either the drill shank started revolving in the tailstock or else the belt started slipping. Several schemes were roughly got out on paper but all were turned down, the usual difficulty being to ensure that when finished the spindle was parallel with the front edge of the bed.

One day I poured out my woes to a friend (a pukka engineer) who was in the shed. He borrowed an envelope and on the back of it, within five minutes, had presented me with the solution.

Briefly, the idea was to line up the spindle parallel with the front edge of the bed, clamp tailstock firmly to soleplate, machine or file the front and rear of the clamped tailstock and soleplate. Make and secure to the front and rear of the soleplate, two guiding strips, the rear guiding strip to be tapped to take two $\frac{1}{4}$-in. B.S.F. adjusting-bolts which engage with two wedge-shaped slots cut in the tailstock. This work, when finished, exceeded all my expectations. The "designer" called a week later and was immediately hurried out into the shed to see the result of his brains and my workmanship. The clock was put in the tool-post and engaged with the spindle, the adjusting screws were turned and the hand of the clock started walking round the dial. The brains of the party then very meticulously turned the screws a fraction at a time—on asking what he was expecting, his reply was "I just wanted to satisfy myself that it will register half a division"—my clock reads to 10 thou.

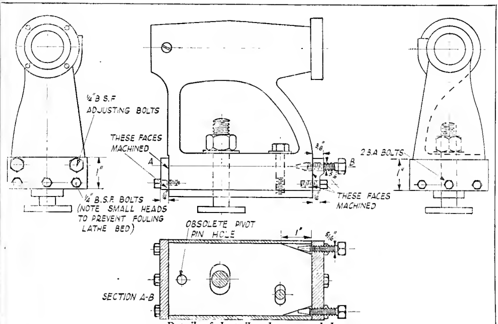
Now for the actual work :—

Materials required—Steel, $2\frac{1}{2}$ in. × 1 in. × $\frac{1}{4}$ in. and $2\frac{1}{2}$ in. × 1 in. × $\frac{3}{8}$ in. ; $\frac{1}{4}$ in. B.S.F. bolts, 3 at $\frac{5}{8}$ in., 2 at $1\frac{3}{8}$ in. ; 2 B.A. bolts, 3 at $\frac{5}{8}$ in.

(1) With a "clock," line tailstock spindle parallel to front edge of bed and clamp to soleplate—check alignment again after clamping.
(2) Remove from lathe, take off handwheel and remove spindle.
(3) Clamp in machine-vice on shaper and machine rear end.
(4) Reverse in vice with the previously machined surface well bedded down on the vice and machine.

NOTE.—Make sure that the machined surface is properly bedded down, as this will ensure that both the machined surfaces are parallel. The fact that the machined faces are not at right-angles to the spindle does not affect the parallel set-over. Machining could be done in the lathe, or for that matter, filed, as it is only necessary to ensure that the front and rear are parallel in one plane.

(5) Separate tailstock from soleplate, and tap and drill soleplate—three 2 B.A. at front and three $\frac{1}{4}$-in. B.S.F. at rear.
(6) Cut, file, drill and tap the two guide-strips to the dimensions shown.
(7) Clamp tailstock, with suitable packing-pieces to cross-slide of lathe and machine adjusting slots with a $\frac{5}{16}$-in. end mill. These slots could be filed or machined on the shaping machine (provided one has a large enough machine-vice to hold a casting of this size). It will be noticed that these slots are 1 in. long in line with the lathe bed and $\frac{5}{16}$ in. long across the bed. These measurements are not haphazard, they serve a definite purpose.



Details of the tailstock as amended

A $\frac{1}{4}$-in. B.S.F. has 26 threads per inch, therefore one thread = 0.0384 in. But one turn of the adjusting-screw will only advance the tailstock $\frac{5}{16}$ in. or 0.0384, which equals 0.012; therefore 1 flat of the adjusting-screw = $0.012 \div 6 = 2$ thou.

This saves a lot of bother if the tailstock is to be set over a definite amount, i.e., if the tailstock is to be set over 25 thou., the adjusting-screw is turned two complete turns and half a flat.

(8) Carefully draw file and finish with emery cloth one of the machined faces of the tailstock—this is to provide working clearance, as otherwise it will be found that when the guide-strips are tightened hard against the soleplate the tailstock will be locked solid.

(9) Chamfer the ends of two $\frac{1}{4}$-in. B.S.F. bolts at the same angle as the adjusting slots for use as adjusting-bolts.
NOTE.—Although I have used commercial bolts, I suggest that special bolts be made. These bolts should be slightly oversize so that they move stiffly in the guide-strip. With commercial bolts, all the looseness and backlash has to be taken up before they start moving the tailstock.

(10) Assemble, oil and see if the adjusting-screws move the tailstock, if they do not, more clearance will be required between the tailstock and the guide-strips.

Although this is written as a means of improving a popular type of lathe, the idea could no doubt be adapted to fit a soleplate to a fixed type tailstock so that it could "set over."

The "Eureka" Electric Clock

(*Continued from page* 201)

shank of the pivot after assembly, and this may even be an advantage, as it provides some adjustment of timing, which may be useful, in getting the clock to work efficiently. This cheek also has a hole drilled to take the insulating bush of the contact pin, and a sawcut is taken from this hole, tangentially out to the edge of the flange, and fitted with a clamping screw. If it is found difficult to obtain or fit a screw as small as 12 B.A., the flange may be made thicker to permit the fitting of a larger screw, say 10 B.A., or $\frac{1}{16}$ in. It may also be noted that the pivot shank, specified as 0.095 in. dia., or 3/32 in., may be increased in diameter with advantage from the structural aspect.

The pivots are made of silver-steel, and it is recommended that they should be made in a single piece for the purposes of initially building up the wheel, the centre part being cut out afterwards; or better still, a temporary mandrel with the true point centres may be used. Chuck the steel truly, in a collet chuck if available, or failing this, by any method which will ensure true running to the closest possible limit, and turn down the ends. In this case also, some increase in the diameter is permissible, indeed advisable, and $\frac{1}{16}$ in. or 0.0625 in. is a suitable dimension. The pivot shank registers in the centre holes of the side plates, and locates the cheeks in position on them; the screw holes for securing them can then be drilled and counterbored, and the screws permanently fitted. In order to allow the pivot shank to pass through the complete wheel assembly, a clearance hole is drilled diametrically through the centre of the core piece, and it is important that this should not bind on the pivot shank or it may spring the wheel out of truth. The shank should be a press fit through the cheeks and side plates, and before fitting it, the ends may be hardened and tempered, and polished, taking great care to ensure a high finish on the radius. When the assembly is put together and spun between centres, it should spin practically dead truly, and if this condition is obtained, the clamp screw holes should be opened out to a dowel fit for the screws—which it will be noted, are screwed only for a sufficient length to engage the tapped holes in the one side plate—and the latter fitted. In the event of any bad errors in the truth of the wheel, the cause must be sought in inaccuracies of workmanship, in locating or aligning the holes, or the position of the clamp blocks.

At this stage, the end faces of the side plates and the core may be finished by taking a skim over them, but it is not advisable to do this by mounting the wheel on its fragile pivots. It is better to hold one of the cheek flanges by its rim in the three-jaw chuck, assuming the latter to be at least reasonably true, and steady the projecting pivot by a hollow centre in the tailstock. The holes for the poise screws in the rim may be marked out, drilled and tapped; it will be seen that these are not equally spaced, the four at the free end of each arc being closer than the other two at the fixed end; but their positions are not critical. Rather large screws, with shanks tapped 0 B.A., are used, but this feature also is optional, and smaller shanks may be used if desired. The slots for clamping the rim and the blocks securely to the core can most readily be cut by using a small circular saw in the lathe, the core piece, of course, being removed during this operation.

(*To be continued*)